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TECHNICAL REPORT 3110

DETERMINATION OF THE FEASIBILITY OF INITIATING PB-RDX PELLETS USING THE M46 STAB DETONATOR

LEONARD SHAINHEIT
ROBERT L. WAGNER

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PICATINNY ARSENAL
DOVER, NEW JERSEY

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DETERMINATION OF THE FEASIBILITY OF INITIATING PB-RDX PELLETS USING THE M46 STAB DETONATOR

BY

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SEPTEMBER 1963

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AMMUNITION ENGINEERING DIRECTORATE
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DOVER, NEW JERSEY

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SECTION I

INTRODUCTION

This investigation was conducted to determine if pellets of PB-RDX explosive could be initiated directly by the M46 Stab Detonator.

Usually PB-RDX, a relatively insensitive secondary explosive, is not used in applications where it is required to be initiated directly by a detonator. By employing the proper design techniques and utilizing a detonator which has sufficient output, a system for directly initiating PB-RDX pellets would be feasible.

Recently, a proposal was made for the development of a helicopter landing device utilizing certain existing hardware. Combining the fuze and main charge by simple logical means would create a system wherein the M46 Detonator would be required to initiate PB-RDX pellets directly. Prior to proceeding with the development, a program was initiated to determine the feasibility of using the M46 Detonator to initiate a PB-RDX pellet.

In the series of tests conducted, restrictions were imposed upon the system consisting of barriers (air gaps, stainless steel and brass strips), extreme cold temperature (-65°F), and reduced detonator confinement. The results of these tests are contained in this report.

SECTION II

SUMMARY

The M46 Stab Detonator was used to initiate PB-RDX pellets under varied test conditions.

Tests were conducted at ambient temperature with the M46 Detonator in direct contact with the PB-RDX pellet and with air gaps of up to 0.2 inch or barriers of up to 0.010 inch-thick stainless steel. There was no failure of the detonator to initiate the PB-RDX pellet in these tests. However, when an air gap of 0.4 inch or a barrier of 0.036 inch-thick brass was introduced into the system failures were produced in several instances.

Similar tests were conducted at -65°F. In these tests, no failure of the detonator to initiate the pellet was observed when the detonator was in direct contact with the pellet. However, when an air gap of 0.2 inch was introduced between the detonator and pellet, failure was observed.

SECTION III

CONCLUSION

It is feasible to directly initiate PB-RDX pellets using the M46 Stab Detonator.

SECTION IV

RECOMMENDATIONS

1. Work should be continued on the proposed helicopter landing device with the approach of using the M46 Stab Detonator to initiate PB-RDX pellets.

2. The final design should be subjected to an environmental and reliability test program.

SECTION V

STUDY

Tests were conducted to determine if the M46 Stab Detonator (Figure 1) could initiate a PB-RDX pellet (Figure 2) under a variety of conditions. The test results are summarized in Table 1.

Detailed results of the entire test series are recorded in Tables 1-10. These results are discussed further in the following.

A test group of 26 each M46 Stab Detonators were placed in direct contact with PB-RDX pellets (Figure 3a). In the test, the detonators were required to initiate the PB-RDX pellets directly. To prevent pitting within the dent made in steel plate by the detonation of the PB-RDX explosive, a thin film of vaseline petroleum jelly was placed between the pellet and plate as per MIL-STD-316. A description of the materials used is given in Appendix C. The detonators were fired by dropping a two-ounce steel ball from a height of 13 inches onto the firing pin. A steel dent test was used to determine output of the PB-RDX pellet. A Starret depth gauge with stand as per MIL-STD-316 was used to measure the dent formed in the steel plate. Values are recorded in Table 2. The average depth of indentation, as recorded in the table, is 0.058 inch. Based on experience this is considered indicative of a high order detonation. The results obtained were encouraging since no failure was encountered even though the confinement afforded the detonators by the polyethylene fixtures (Figure 4) was less than that planned for it in the end item, the M607 Mine fuze (Figure 5).

Using a set-up as in Figure 3a, ten each M46 Stab Detonators and PB-RDX pellets were tested at -65°F. The indentations made in steel plate are recorded in Table 3. As shown in the table, the average dent obtained was 0.042 inch. This value was considerably lower than the 0.058 inch obtained in the previous test. It was observed that the vaseline petroleum jelly located between the pellet and the steel plate had hardened at -65°F, thereby creating a barrier between the pellet and steel plate. This vaseline barrier attenuated the pellet output, producing the relatively small indentations. To determine the validity of this explanation, a control test was conducted in which the only change made was to omit the vaseline coating. The results are also reported in Table 3. The average dent produced was 0.053 inch. This dent is appreciably different from 0.042 inch obtained with the vaseline at -65°F and seems to confirm the above reasoning. The results show that the M46 Detonator is capable of effecting initiation of PB-RDX when subjected to extreme cold temperature. It should be noted that the detonator confinement used in this test, as in the previous test, was only a thin polyethylene sleeve.

To create a more difficult task for the detonators, they were separated from the pellets by air gaps of 0.200 ± 0.009 inch (except in two cases, i.e., 0.273 and 0.313 inch). The loaded fixture (Figure 3b) was tested in the apparatus shown in Figure 3a. The detonators were held in place by an epoxy adhesive, Hysol 2038 using Hardner C, No. 3475, described in Appendix C. Before conducting these tests, an investigation was conducted to ascertain if the adhesive had sufficient strength to hold the detonator in position. This was necessary to assure that the detonator was not pushed down on top of the pellet (thereby reducing the size of or eliminating the air gaps completely) when the stab pin was struck by the ball. Five plugs (cut from 1/4-inch aluminum rod to the size of the M46 Detonator) were substituted for the detonators and placed in the apparatus in Figure 3b. Measurements of air gaps before and after ball drop were made and are recorded in Table 4. A comparison of the average air gap before and after ball drop indicated that the epoxy adhesive had sufficient strength to reliably hold the detonator in place.

In the 0.2-inch air gap test at ambient temperature, the indentations made in steel plate by the PB-RDX pellets are recorded in Table 5. A comparison of the average indentation produced with the detonator directly on the pellet (0.058 inch) and with the detonator separated by a 0.2-inch air gap (0.059-inch), showed there was no apparant change in pellet output due to imposition of this air gap.

However, in one of these tests the detonator was not initiated. There are several possible explanations accounting for this occurrence. First, it is possible that the steel ball used in the drop test did not strike the stab pin squarely, thereby transfering an insufficient quantity of impact energy to the detonator. A second explanation is based upon the contention that an excess of epoxy adhesive hardened above the detonator and had sufficient strength to prevent the stab pin from penetrating into the detonator. Examination of the detonator and test apparatus indicated that the former expanation was applicable. No adhesive was observed above the detonator but it was noticed that a bolt holding the steel pipe in which the steel ball was dropped (Figure 3a), had loosened. The pipe was tilted at an angle indicating the ball did not strike the stab pin squarely. The bolt was tightened and the pipe realigned. The set-up was examined before each successive test to prevent any future recurrence.

The test was repeated at -65°F using an air gap of about 0.2 inch between the detonator and pellet. The results of this test are recorded in Table 6. The average depth of indentation in steel plate was 0.052 inch. This value agrees with that obtained in the control test conducted at -65°F with no air gap imposed between the detonator and pellet. Just as in the

control test, vaseline was not used between the pellet and steel plate. Thus, the result obtained, further substantiated the opinion that at a cold temperature the vaseline hardened forming an attenuating barrier between the pellet and steel plate.

In the next test, the pellets were separated still farther from the detonator by air gaps of 0.399 to 0.031 inch. In 11 of the 14 tests, the pellets were successfully initiated. The results are recorded in Table 7. It is considered that the failures are due to the presence of the relatively large air gaps employed in these tests. As the conditions imposed upon the system become more severe, the chance of failure increases. It is apparent from the results that 0.319-inch air gap far exceeds the air gap over which PB-RDX can be reliably initiated by the M46 Detonator.

Figure 3c shows the loaded fixture for determining the affect of metal barriers on the probability of initiating PB-RDX by the M46 Stab Detonator. The test results are recorded in Tables 8-10. The average indentations obtained in these tests ranged from 0.064 to 0.066 inch. The value obtained in the tests with the detonator in direct contact with the pellet, was 0.055 inch.

The increased average dent was attributed to the presence of the metal barrier between the detonator and pellet. Several theoretical explanations accounting for this phenomenon are available. However, determining the validity of these would necessitate further investigative effort which the authors believe is beyond the scope of this task.

As seen from the tables, only the 0.036 inch-thick brass strip (in 3 out of 10 tests) attenuated the detonator output sufficiently to prevent pellet initiation. These failures were not unusual since the barrier thickness was large. The output of the detonator was attenuated to a value which produced a detonation rate near the critical value for the explosive. Being in a critical region, failures were to be expected.

The tests described above were conducted over a wide range of rather severe conditions. This was necessary to determine not only the feasibility of initiating PB-RDX pellets using the M46 Detonator, but also to obtain some information concerning the limitations under which this could be effected. The findings of these tests indicated that there is a range of design conditions under which reliable functioning may be obtained. Since it is expected that the intended end item design will be within this range, it is suggested that work be initiated on application of an M46 Detonator PB-RDX system in the helicopter landing device.

APPENDICES

APPENDIX A

TABLES

TABLE I

SUMMARY OF TEST CONDUCTED TO DETERMINE THE FEASIBILITY OF INITIATING PB-RDX PELLETS USING THE M46 STAB DETONATOR

Gap or Barrier Between Detonator and Pellet		Test Temp (°F)	Nr. Tested	Nr. PB-RDX Pellets Initiated	Nr. PB-RDX Pellets Not Initiated	Avg. Dent in Steel (Inches)	Range of Dent in Steel (Inches)	
Thickness; Inches	Material						Max.	Min.
	None	A. T.[1]	26	26	0	0.058	0.066	0.048
	None	-65	10	10	0	0.042[2]	0.044	0.038
0.200 ± 0.009[3]	Air	A. T.	12	11	1[4]	0.059	0.065	0.055
0.199 ± 0.008	Air	-65	11	10	1	0.052	0.055	0.048
0.399 - 0.031	Air	A. T.	14	11	3	0.056	0.060	0.053
0.005	Stainless Steel	A. T.	10	10	0	0.064	0.068	0.061
0.010	Stainless Steel	A. T.	10	10	0	0.064	0.068	0.060
0.036	Brass	A. T.	10	7	3	0.066	0.072	0.059

NOTES:

1. Ambient Temperature (approx. 70° F)
2. The low value is attributed to a vaseline barrier between pellet and steel block (see pages 4-6 for further details).
3. Two air gaps were unintentionally made larger (0.273 and 0.313 inch).
4. The M46 Stab Detonator was not initiated in this test.

TABLE II

INITIATION OF PB-RDX PELLETS USING THE M46 STAB DETONATOR AT AMBIENT TEMPERATURE

Test Number	Depth of Indentation in Steel Plate (inches)
1	0.062
2	0.066
3	0.058
4	0.065
5	0.062
6	0.061
7	0.055
8	0.057
9	0.051
10	0.058
11	0.058
12	0.062
13	0.060
14	0.059
15	0.059
16	0.059
17	0.060
18	0.059
19	0.055
20	0.060
21	0.057
22	0.056
23	0.053
24	0.057
25	0.048
26	0.052
Avg	0.058
Max	0.066
Min	0.048

Note: Test set up is shown in Figure 3a. The detonator was initiated by a two-ounce steel ball dropped 13 inches

TABLE III

INITIATION OF PB-RDX PELLETS BY THE M46 STAB DETONATOR AT -65°F

Test Number	Depth of Indentation in Steel Plate (inches)	Control Test Number *	Depth of Indentation in Steel Plate (inches
1	0.040	1	0.055
2	0.044	2	0.054
3	0.038	3	0.056
4	0.040	4	0.053
5	0.041	5	0.055
6	0.043	6	0.054
7	0.042	7	0.056
8	0.038	8	0.049
9	0.042	9	0.051
10	0.042	10	0.050
Avg	0.042		0.053
Max	0.044		0.056
Min	0.038		0.049

Note: Test set up is shown in Figure 3a
*No vaseline was used to hold pellet on steel plate. The detonator was initiated by a two-ounce steel ball dropped 13 inches.

TABLE IV

QUALITATIVE INDICATION OF EPOXY ADHESIVE[1] STRENGTH UNDER IMPACT[2]

Number Tested		Air Gap Before Impact (inches)		Air Gap After Impact (inches)
1		0.207		0.207
2		0.199		0.199
3		0.202		0.201
4		0.209		0.210
5		0.204		0.204
	Avg	0.204	Avg	0.204

Note: Test set-up shown in Figure 3b.
Aluminum rods, equal dimentionally to the M46 Stab Detonator, were used in place of the detonators.
PB-RDX pellets were not used in this test.

1. Hysol epoxy adhesive, No. 2038, using Hardener C, No. 3475.
2. A two-ounce steel ball was dropped 13 inches onto the stab pin.

TABLE V

INITIATION OF PB-RDX PELLETS USING THE M46 STAB DETONATOR ACROSS AIR GAPS AT 70°F

Test Number	Air Gap (inches)	Depth of Indentation in Steel Plate (inches)
1	0.206	0.061
2	0.203	0.057
3	0.207	0.058
4	0.208	0.055
5.	0.199	0.065
6	0.206	0.059
7	0.209	0.061
8	0.273	0.058
9	0.202	0.061
10	0.206	0.058
11	0.313	0.061
12	0.209	*
Avg	0.219	0.059
Max	0.313	0.065
Min	0.199	0.055

Note: The test set up is shown in Figure 3b.
*The M46 Stab Detonator did not fire.
The detonator was initiated by a two-ounce steel ball dropped 13 inches.

TABLE VI

INITIATION OF PB-RDX PELLETS USING THE M46 STAB DETONATOR THROUGH AIR GAPS AT -65°F

Test Number	Air Gap (inches	Depth of Indentation in Steel Plate (inches)
1	0.201	0.051
2	0.205	0.048
3	0.199	*
4	0.203	0.053
5	0.207	0.050
6	0.201	0.048
7	0.706	0.054
8	0.205	0.051
9	0.207	0.053
10	0.204	0.055
11	0.205	0.054
Avg	0.204	0.052
Max	0.207	0.055
Min	0.048	0.048

Note: The test set up is shown in Figure 3b.
*The PB-RDX pellet failed to detonate. The detonators were initiated by a two-ounce steel ball dropped 13 inches.

TABLE VII

INITIATION OF PB-RDX PELLETS USING THE M46 STAB DETONATOR THROUGH AIR GAPS AT 70°F

Test Number	Air Gap (inches)	Depth of Indentation in Steel Plate (inches)
1	0.380	0.058
2	0.392	0.053
3	0.391	0.055
4	0.389	*
5	0.395	0.057
6	0.371	0.059
7	0.399	*
8	0.377	0.053
9	0.383	*
10	0.370	0.053
11	0.369	0.059
12	0.368	0.060
13	0.394	0.057
14	0.399	0.059
Avg	0.384	0.056
Max	0.399	0.060
Min	0.368	0.053

Note: The test set up is shown in Figure 3b.
*The PB-RDX pellets failed to detonate.
The detonators were initiated by a two-ounce steel ball dropped 13 inches.

TABLE VIII

INITIATION OF PB-RDX PELLETS USING THE M46 STAB DETONATOR THROUGH A 0.005 INCH-THICK STAINLESS STEEL BARRIER AT 70°F

Test Number	Depth of Indentation in Steel Plate (inches)
1	0.068
2	0.061
3	0.067
4	0.063
5	0.064
6	0.064
7	0.064
8	0.061
9	0.066
10	0.061
Avg	0.064
Max	0.068
Min	0.061

Note: Test set up is shown in Figure 3c. The detonators were initiated by a two-ounce steel ball dropped 13 inches.

TABLE IX

INITIATION OF PB-RDX PELLETS BY THE M46 STAB DETONATOR THROUGH A 0.010 INCH-THICK STAINLESS STEEL BARRIER AT 70°F

Test Number	Depth of Indentation in Steel Plate (inches)
1	0.063
2	0.063
3	0.060
4	0.067
5	0.068
6	0.065
7	0.065
8	0.055
9	0.065
10	0.068
Avg	0.064
Max	0.068
Min	0.060

Note: Test set up is shown in Figure 3c. The detonators were initiated by a two-ounce steel ball dropped 13 inches.

TABLE X

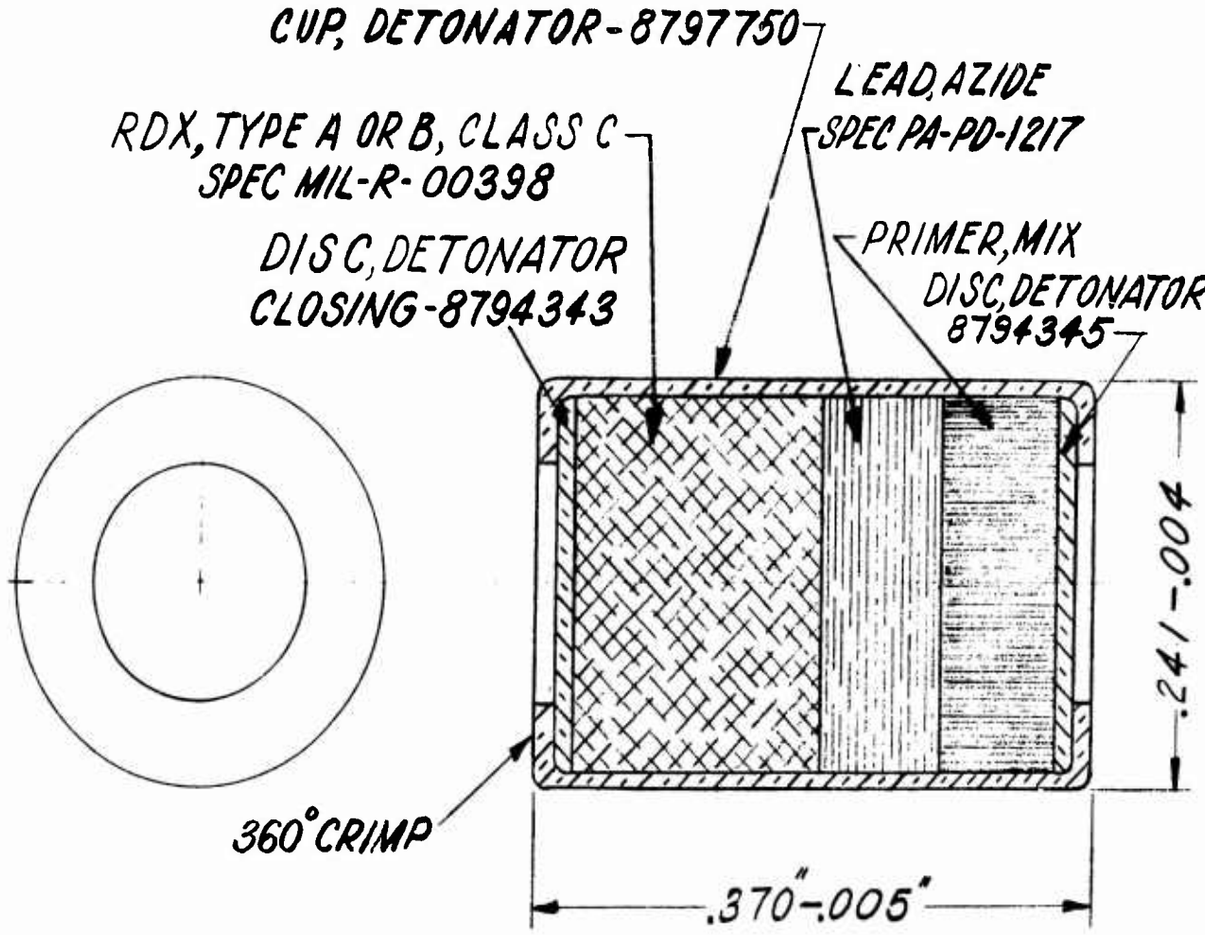
INITIATION OF PB-RDX PELLETS BY THE M46 STAB DETONATOR THROUGH A 0.036 INCH BRASS BARRIER AT 70°F

Test Number	Depth of Indentation in Steel Plate (inches)
1	0.064
2	0.065
3	*
4	0.065
5	0.065
6	0.059
7	*
8	*
9	0.070
10	0.072
Avg	0.066
Max	0.072
Min	0.059

Note: Test set up is shown in Figure 3c.
*PB-RDX pellets failed to detonate.
The detonators were initiated by a two-ounce steel ball dropped 13 inches.

APPENDIX B

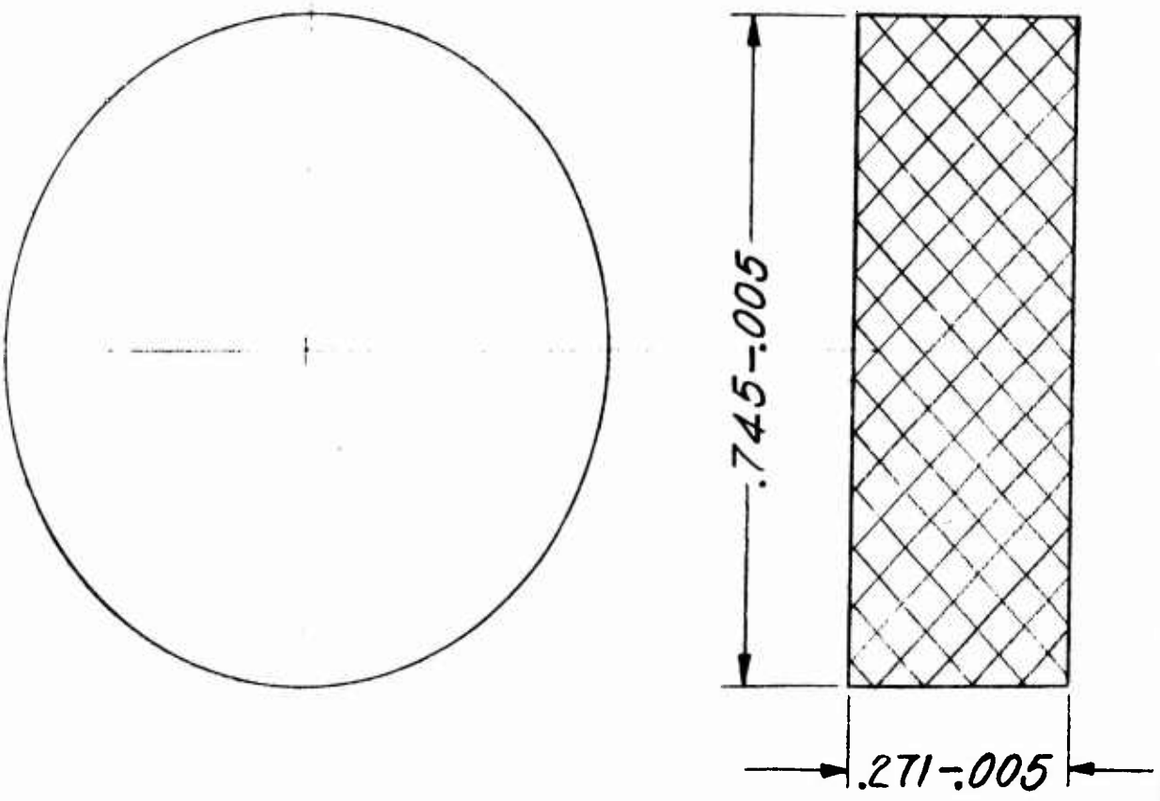
FIGURES



NOTE:
FURTHER INFORMATION MAY BE OBTAINED IN ORDNANCE CORPS DRAWING NO. 8797793.

DETONATOR, STAB, M46

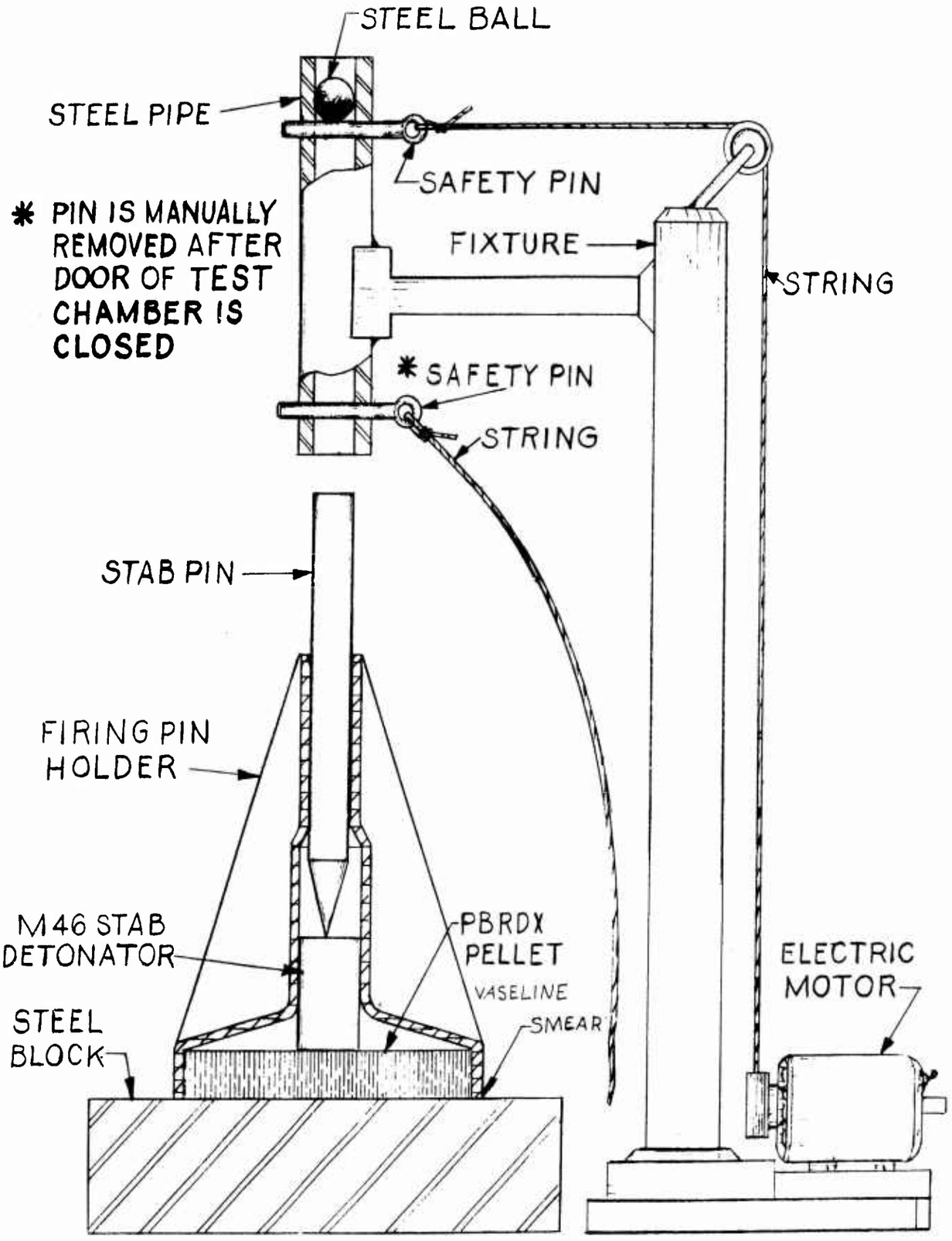
FIGURE 1



NOTE :-
WEIGHT :- 3.04 - .14 GRAMS
MATERIAL :- POWDER, PBX, TYPE A,
.057 LB/CU. IN.
FOR FURTHER INFORMATION SEE
ORDNANCE CORPS DWG NO. XP-113188.

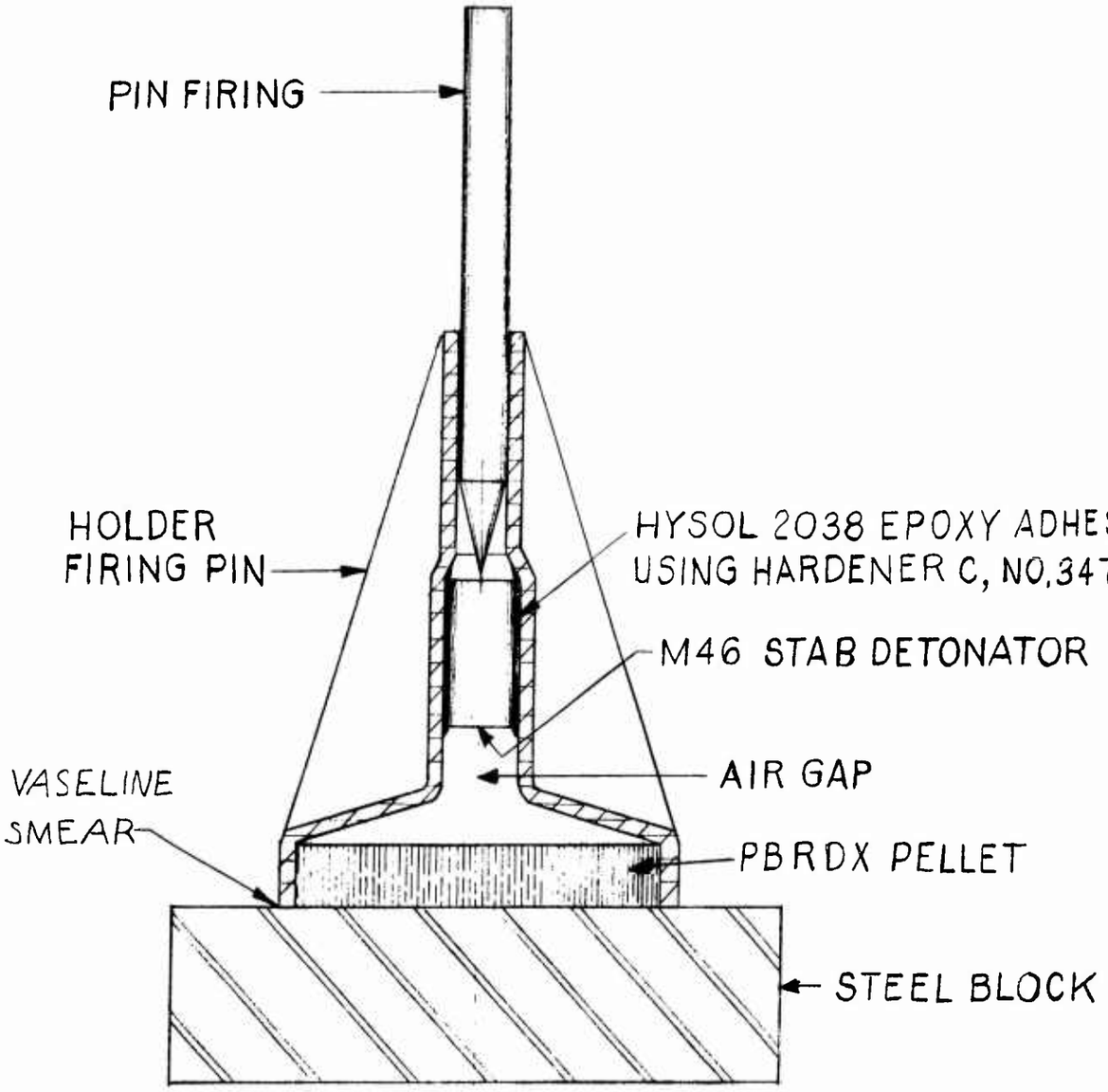
PB-RDX PELLET

FIGURE 2



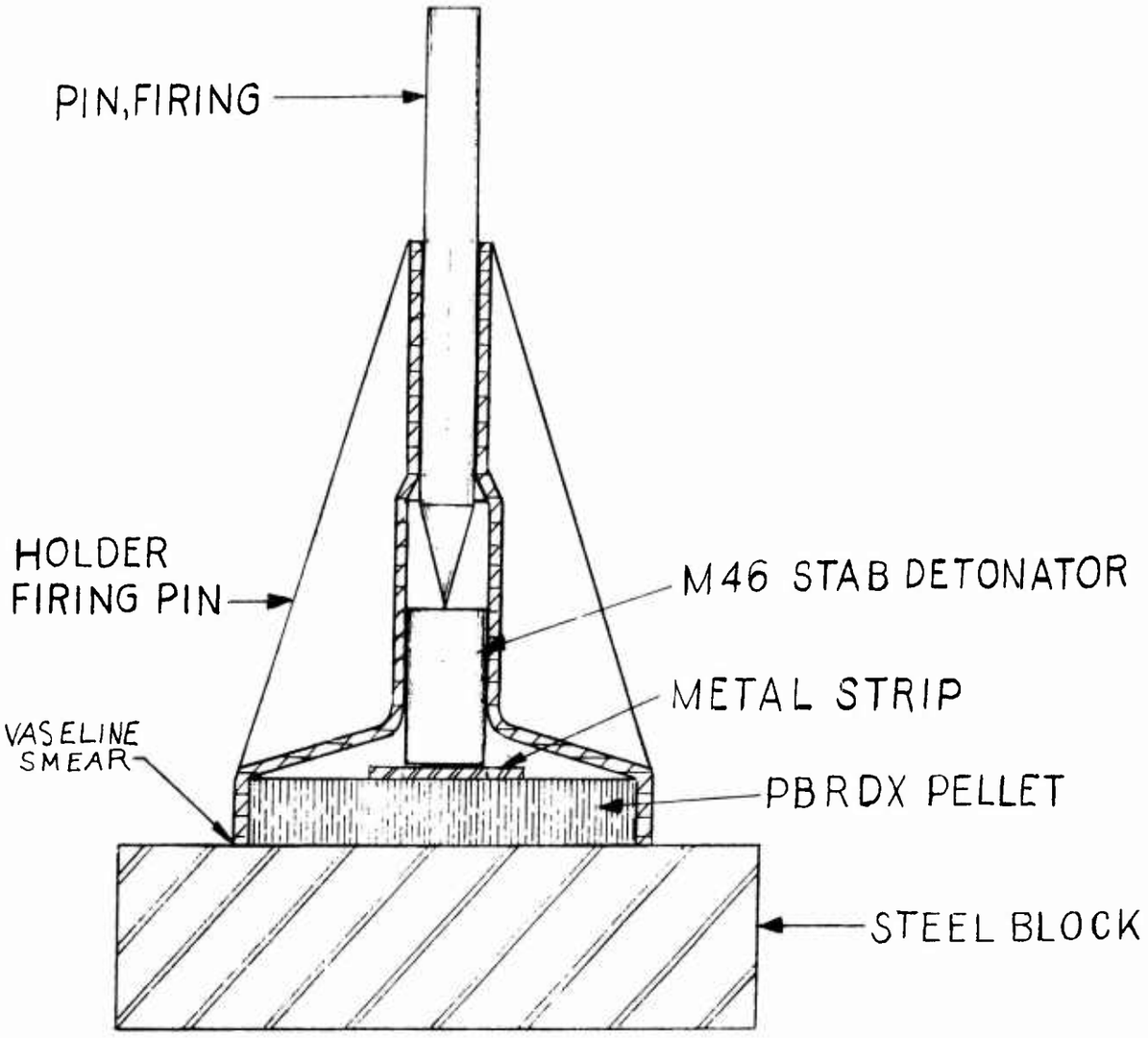
TEST SETUP SHOWING DETONATOR DIRECTLY ON PELLET

FIGURE 3a.



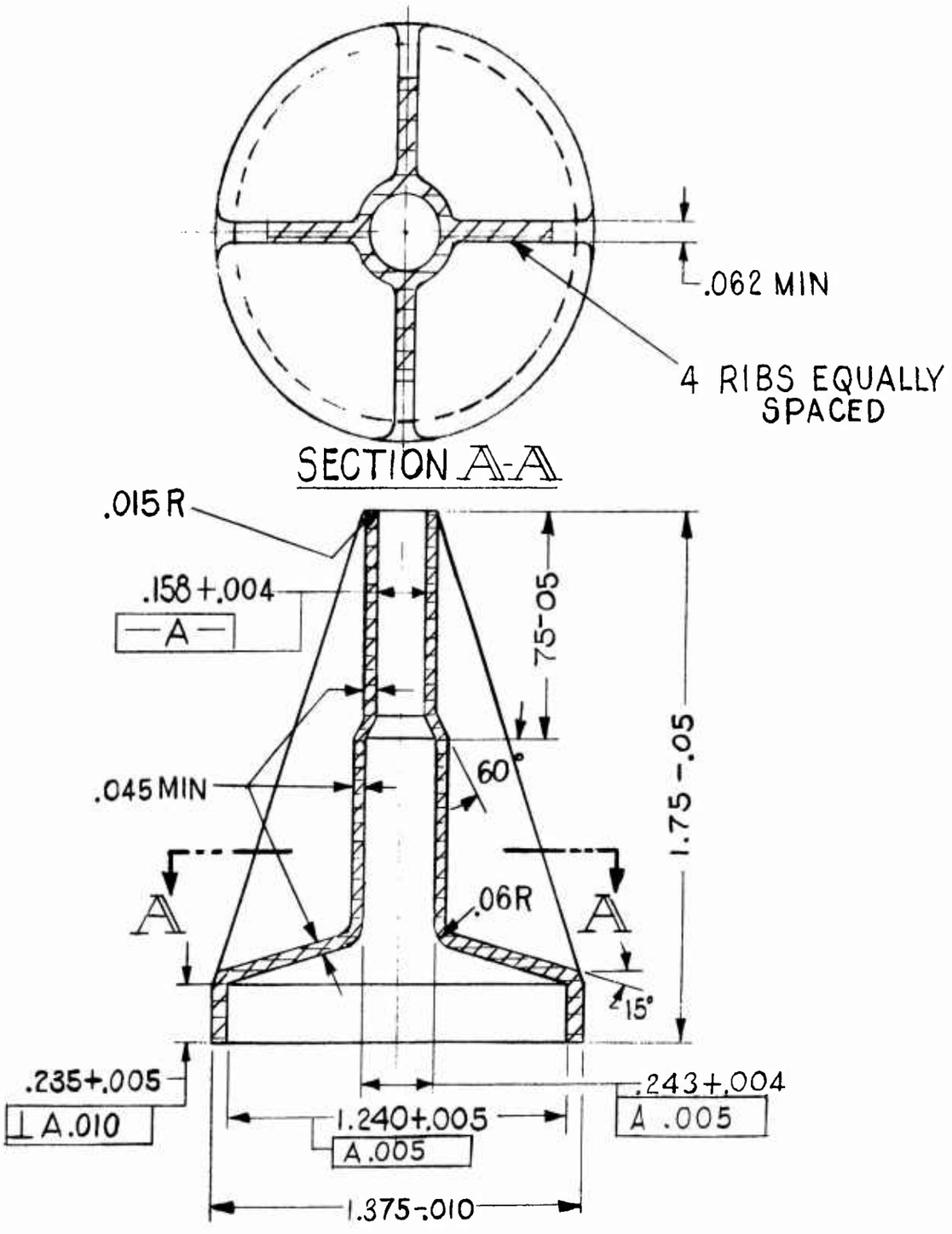
TEST SETUP SHOWING DETONATOR SEPARATED FROM PELLET BY AIR GAP

FIGURE 3b.



TEST SETUP SHOWING DETONATOR SEPARATED FROM PELLET BY METAL BARRIER.

FIGURE 3C.



HOLDER, FIRING PIN
MOLDED POLYSTYRENE, TYPE I, SPEC L-P-416

NOTES:-
1. FLASH MARKS AND DRAFT ALLOWABLE ONLY ON EXTERNAL SURFACE.
2. SPEC MIL-A-2550 APPLIES.

FIGURE 4

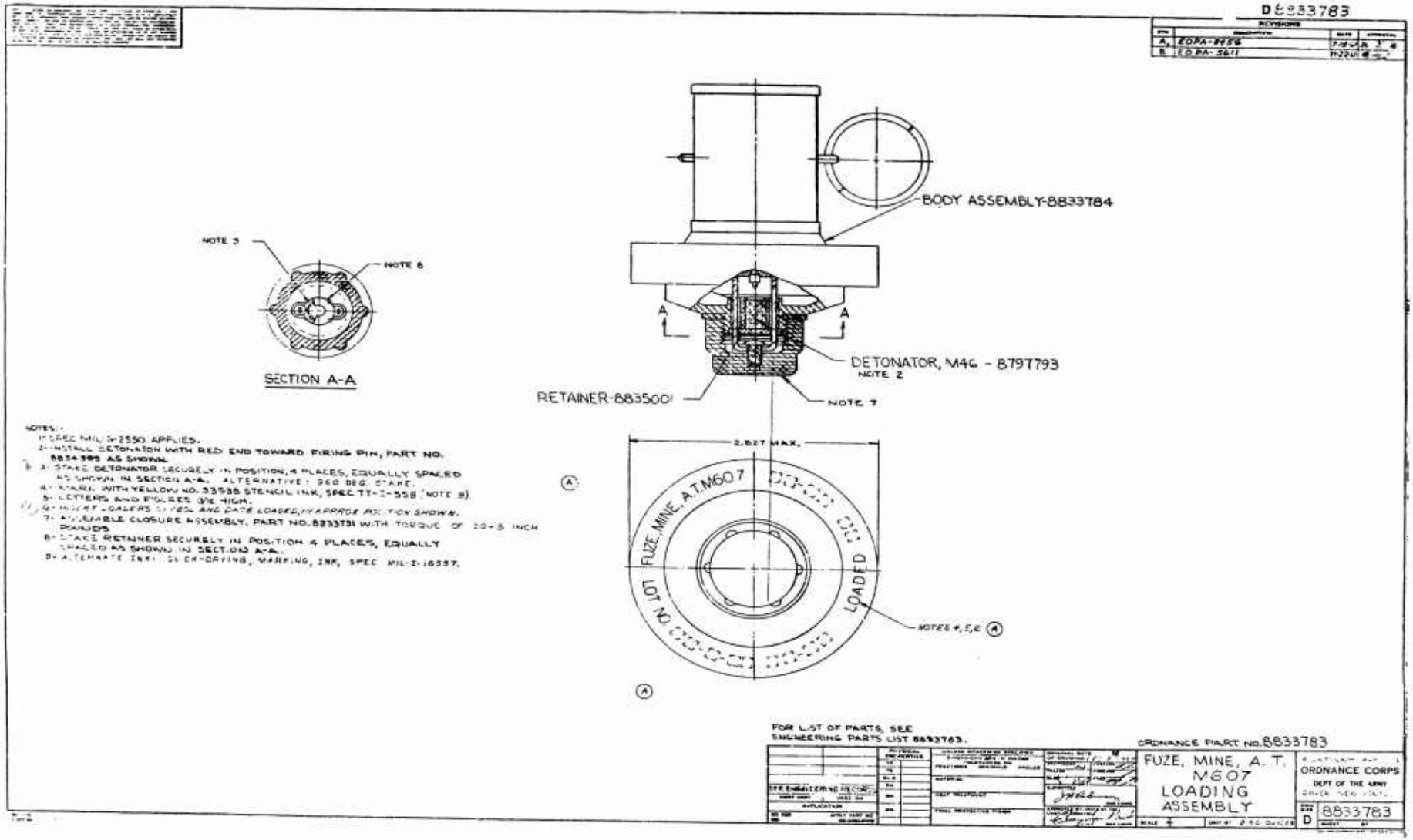
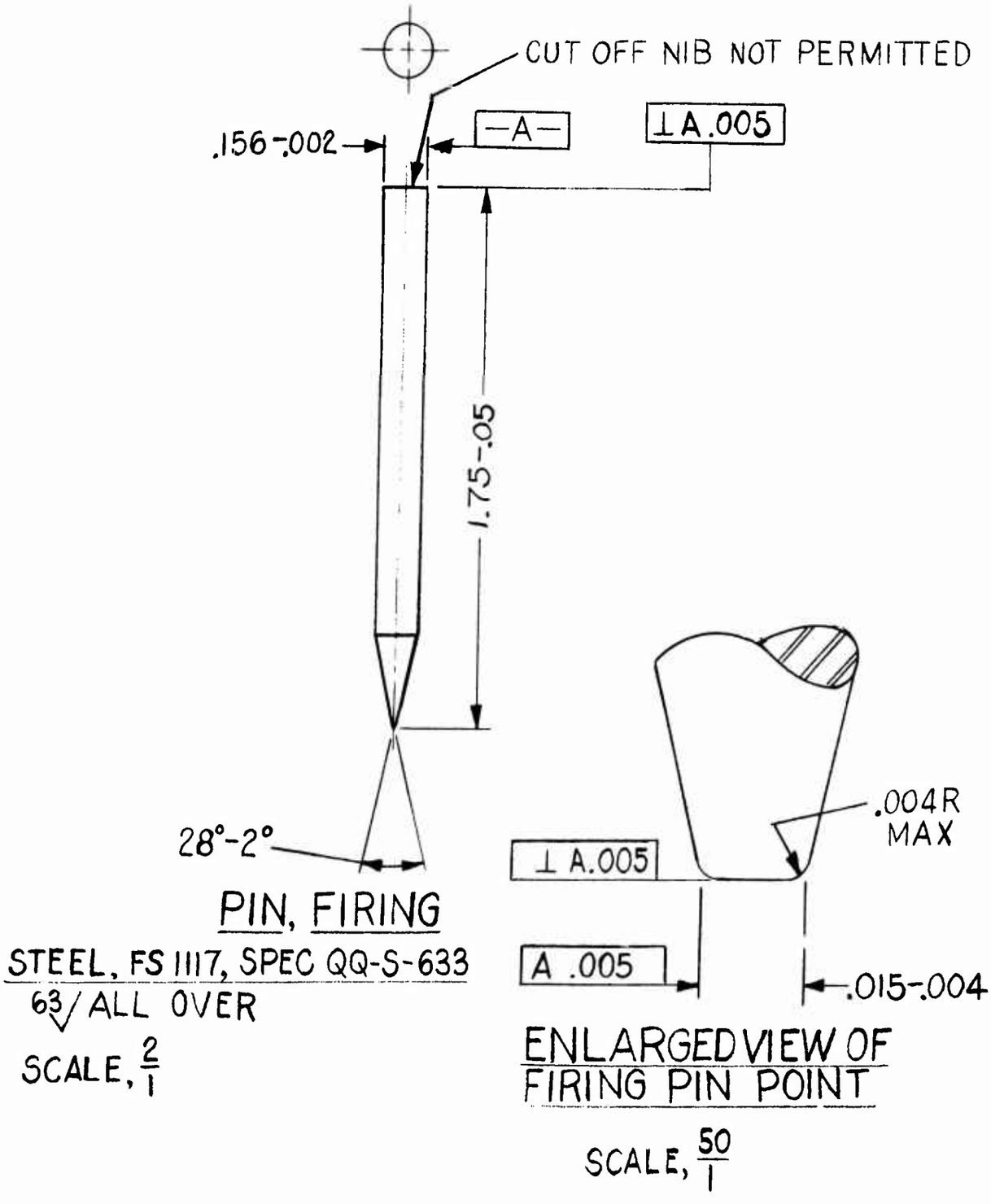

D 8933783
REVISIONS
A ECPA-8956
B ECPA-5611
BODY ASSEMBLY-8833784
NOTE 3
NOTE 8
SECTION A-A
A
A
DETONATOR, M46 - 8797793
NOTE 2
RETAINER-8835001
NOTE 7
2.827 MAX.
FUZE, MINE, A.T. M607
LOT NO
LOADED
NOTES 4, 5, 6
NOTES:-
1- SPEC MIL-P-2550 APPLIES.
2- INSTALL DETONATOR WITH RED END TOWARD FIRING PIN, PART NO. 8834395 AS SHOWN.
3- STAKE DETONATOR SECURELY IN POSITION, 4 PLACES, EQUALLY SPACED AS SHOWN IN SECTION A-A. ALTERNATIVE: 360 DEG. STAKE.
4- MARK WITH YELLOW NO. 33538 STENCIL INK, SPEC TT-I-558 (NOTE 9)
5- LETTERS AND FIGURES 3/16 HIGH.
6- INSERT LOADERS INITIALS AND DATE LOADED IN APPROX POSITION SHOWN.
7- APPLICABLE CLOSURE ASSEMBLY, PART NO. 8833731 WITH TORQUE OF 20-5 INCH POUNDS.
8- STAKE RETAINER SECURELY IN POSITION 4 PLACES, EQUALLY SPACED AS SHOWN IN SECTION A-A.
9- ALTERNATE INK: IN ACCORDING, MARKING, INK, SPEC MIL-I-16337.
FOR LIST OF PARTS, SEE ENGINEERING PARTS LIST 8833783.
ORDNANCE PART NO. 8833783
FUZE, MINE, A.T. M607 LOADING ASSEMBLY
ORDNANCE CORPS
DEPT OF THE ARMY
SIZE D
8833783

FIGURE 5



PIN, FIRING

STEEL, FS 1117, SPEC QQ-S-633

63 ALL OVER

SCALE, 2/1

ENLARGED VIEW OF FIRING PIN POINT

SCALE, 50/1

SPEC MIL-A-2550 APPLIES.

FIGURE 6

APPENDIX C

DESCRIPTION OF MATERIALS

DESCRIPTION OF MATERIALS

1. M46 Stab Detonator - Drawing No. 8797793 in Figure 1.
2. PB-RDX Pellets - Drawing No. XP113188 in Figure 2.
3. Polyethylene Fixture - Drawing in Figure 4.
4. Stab Pin - Drawing in Figure 6.
5. Steel Plate:

Length	1.0 inch
Width	1.0 inch
Height	0.5 inch
Specification	QQ-S-635
Type Steel	FF1020
Rockwell Hardness	B70-B95

6. Steel Ball:

Weight	2 ounces
Diameter	0.9 inch
Height above Stab Pin	13 inches

7. Hysol 2038 Epoxy Adhesive Using Hardener C, No. 3475:

   Manufactured by - Hysol Corporation, Olean, New York

   Tensile-Shear Strength for aluminum to aluminum bonding after cure at 70°F - 1,820 psi

ABSTRACT DATA

ABSTRACT

Accession No. _____ AD _____

Picatinny Arsenal, Dover, New Jersey

DETERMINATION OF THE FEASIBILITY OF INITIATING PB-RDX PELLETS USING THE M46 STAB DETONATOR

Leonard Shainheit
Robert L. Wagner

Technical Report 3110, September 1963, 28pp, figures, tables, Unclassified report from the Artillery Ammunition Laboratory, Ammunition Engineering Directorate.

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UNCLASSIFIED

1. Explosives Materials -- Initiation
2. Electric detonators

I. Shainheit, Leonard
II. Wagner, Robert L.
III. PB-RDX pellets
IV. M46 stab detonator

UNITERMS

Initiation
Explosive
Pellets
Detonator
Stab
M46
Shainheit, L.
Wagner, R. L.

TABLE OF DISTRIBUTION

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(over)

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IV. M46 stab detonator

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Initiation
Explosive
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Stab
M46

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Picatinny Arsenal, Dover, New Jersey

DETERMINATION OF THE FEASIBILITY OF INITIATING PB-RDX PELLETS USING THE M46 STAB DETONATOR

Leonard Shainheit

Robert L. Wagner

Technical Report 3110, September 1963, 28 pp. figures, tables. Unclassified report from the Artillery Ammunition Laboratory, Ammunition Engineering Directorate.

The M46 Stab Detonator was used to initiate PB-RDX pellets under varied test conditions.

Tests were conducted at ambient temperature with the M46 Detonator in direct contact with the PB-RDX pellet and

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1. Explosives Materials - - Initiation
2. Electric Detonators

I. Shainheit, Leonard
II. Wagner, Robert L.
III. PB-RDX pellets
IV. M46 stab detonator

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Pellets
Detonator
Stab
M46

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with air gaps of up to 0.2 inch or barriers of up to 0.010 inch-thick stainless steel. There was no failure of the detonator to initiate the PB-RDX pellet in these tests. However, when an air gap of 0.4 inch or a barrier of 0.036 inch-thick brass was introduced into the system failures were produced in several instances.

Similar tests were conducted at −65°F. In these tests, no failure of the detonator to initiate the pellet was observed when the detonator was in direct contact with the pellet. However, when an air gap of 0.2 inch was introduced between the detonator and pellet, failure was observed.

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